TITLE OF THE INVENTION

SOLENOID VALVE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a solenoid valve in which a moving part moves by electromagnetic force to close a valve.

Description of the Related Art

Conventionally, a solenoid valve is arranged such that, when it is energized and electromagnetic force is generated, a moving part having on its tip a valve that moves by the electromagnetic force, and a stroke of the moving part causes the valve to abut a sealing part of a fluid passage, which interrupts a flow of fluid.

The conventional solenoid valve, however, produces an actuating sound (impact sound) caused by a collision between the valve and the sealing part in abutting the valve against the sealing part of the fluid passage. For instance, when the solenoid valve is installed in a vehicle, depending on where the valve is installed, an actuating sound can be transmitted inside a vehicle as a noise.

JP 2001-227671 A (paragraph numbers 0014 to 0036, FIG. 1) discloses a solenoid valve in which an air orifice is formed in a diaphragm to decrease a moving speed of a moving part via the air orifice, thereby reducing loudness of an actuating sound. Nonetheless, a mere decrease in the moving speed of the moving

part bumps immediately against bounds to reduction in the actuating sound, and depending on where the valve is installed, an actuating sound can be transmitted inside the vehicle as a noise.

The conventional solenoid valve thus arranged as above involves a problem that when the valve abuts the sealing part of the fluid passage, an actuating sound is produced by a collision between the valve and the sealing part, and depending on where the valve is installed, the actuating sound can be transmitted inside a vehicle as a noise

SUMMARY OF THE INVENTION

The present invention has been made to solve the above-mentioned problem. An object of the present invention is to provide a solenoid valve which is able to reduce an actuating sound caused by a collision between the valve and the sealing part. The solenoid valve of the present invention is made of elastic materials showing a tendency to yield when the valve abutted the sealing part of the fluid passage.

According to the present invention in which the valve is made of elastic materials developing a tendency to yield when the valve abutted the sealing part of the fluid passage, an impact had when the valve is sealed is absorbed, thereby reducing loudness of the actuating sound caused by a collision between the valve and the sealing part.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a structural drawing showing a solenoid valve according to a first embodiment of the present invention;

FIG. 2 is a structural drawing showing a purview of the solenoid valve shown in FIG. 1;

FIG. 3 is a structural drawing showing a purview of the solenoid valve shown in FIG. 1;

FIG. 4 is a structural drawing showing a purview of the solenoid valve shown in FIG. 1;

FIG. 5 is a structural drawing showing a purview of a solenoid valve according to a second embodiment of the present invention;

FIG. 6 is a structural drawing showing a purview of a solenoid valve according to a third embodiment of the present invention; and

FIG. 7 is a structural drawing showing a purview of a solenoid valve according to a third embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will now be described below with reference to the attached drawings.

First Embodiment

FIG. 1 is a structural drawing showing a solenoid valve according to a first embodiment of the present invention, and FIGS. 2-4 are structural drawings showing purviews of the solenoid valve depicted in FIG. 1.

Referring to FIG. 1, the solenoid valve includes a core

1, rods 3, 5, and a plunger 2. The plunger 2 is made of magnetic materials, and moves to the left as seen in FIG. 1 by electromagnetic force generated when it is energized. The rod 3 is made of non-magnetic materials. When the plunger 2 moved to the left as seen in FIG. 1, the rod 3 is pressed by the plunger 2 and moves to the left. A spring 4 is placed between the rod 3 and the rod 5 which is made of non-magnetic materials. When the rod 3 moved to the left, the rod 5 is pressed by the rod 3 through the spring 4 and moves to the left. In passing, the plunger 2, the rod 3, the spring 4, and the rod 5 constitute a moving part.

A valve as the moving part 6 is fixed on a tip 5a of the rod 5. When the rod 5 moved to the left, the valve abuts a sealing part 9 of a fluid passage 8, thereby interrupting a flow of fluid. The valve 6 is made of elastic materials such as rubber, which yields when the valve abutted the sealing part 9 of the fluid passage 8.

The fluid passage 8 is formed by a nipple 7, and has a stopper 10 provided in the interior thereof. A rib 7a contributes to give strength to the stopper 10. Additionally, the stopper 10 abuts a center 6b of the valve 6 where a yield is occurred so as to prevent the valve 6 being from excessively yielded.

One of a spring 11 is fixed in the interior of the fluid passage 8, and the other end of which is fixed on a metallic plate 6a as a form-stabilizing part of the valve 6. A pipe 12 is provided around the periphery of the plunger 2, and

constitutes a sliding member to suppress a stroke of the plunger 2 by reducing as far as possible a sliding clearance formed between the pipe and the plunger 2. A rubber stopper 13 abuts the rod 5 when the rod 5 returned to the right as seen in FIG. 1. In addition, the moving part has in its terminal a hermetic chamber 14.

The operation of the first embodiment will now be described below.

When the solenoid valve is closed, the solenoid valve is energized, in which case the plunger 2 moves to the left by electromagnetic force generated when the plunger 2 is energized.

Due to this, the rod 3 is pressed by the plunger 2 and moves to the left, while the rod 5 is pressed by the rod 3 via the spring 4 and moves to the left.

As a result, the valve 6 fixed on the tip 5a of the rod 5 moves to the left and abuts the sealing part 9 of the fluid passage 8, thereby interrupting a flow of fluid.

However, since a part of the valve 6 which abuts the sealing part 9 of the fluid passage 8 is made, for instance, of rubber in such a manner as to thin thickness thereof to the utmost, the part yields when it abutted the sealing part 9 of the fluid passage 8, thereby absorbing an impact had when the valve is sealed (at the time of collision). This substantially suppresses production of an actuating sound caused by a collision between the valve 6 and the sealing part 9.

An excessive yield of the valve 6 might cause the valve

6 to enter the interior of the fluid passage 8 of the nipple 7, or the rod 5 to penetrate the valve 6.

For this reason, in the first embodiment, in order to prevent the valve 6 from being excessively yielded, the stopper 10 in pillar shape is provided within the fluid passage 8, and the stopper 10 abuts the center 6b of the valve 6 where a yield is occurred. Mention in passing, the reason why the stopper 10 is formed in pillar shape is to place the stopper 10 within the fluid passage 8 and is not to build air-flow resistance to fluid.

Furthermore, in the first embodiment, the valve 6 includes a plug-in structure to receive an insertion of the tip 5a of the rod 5, and when installing the valve 6 on the tip 5a of the rod 5, the tip 5a of the rod 5 is inserted in the valve 6 (see FIG. 2).

Thereby, a sealing surface of the valve 6 follows up an inclination and a positional deviation of the sealing surface of the sealing part 9 that is a tip of the nipple 7. Consequently, airtightness (fluid-interrupting properties) of the valve 6 is improved.

However, where the valve 6 has a plug-in structure, the rod 5 involves a risk of penetrating the valve 6. On that account, the valve 6 is provided with the metallic plate 6a responsible for form stabilization thereof, and the other end of the spring 11 whose one end is fixed within the fluid passage 8 is fixed on the metallic plate 6a.

Additionally, in the first embodiment, in order to lose

weight of the moving part for reducing impact force generated at the time of collision, the rod is divided into the rod 3 and the rod 5, and the spring 4 is placed between the rod 3 and the rod 5 (see FIG. 3).

This reduces impact force generated at the collision by losing weight of the moving part, which reduces loudness of an actuating sound. Moreover, because the spring 4 is provided between the rod 3 and the rod 5, an impact energy generated when the valve 6 abutted the sealing part 9 is absorbed by damper mechanisms of the spring 4, thereby allowing an actuating sound to be reduced still more.

Besides, in the first embodiment, the pipe 12 is provided around the periphery of the plunger 2 to narrow as far as possible a sliding clearance formed between the plunger 2 and the pipe 12, as well as the hermetic chamber 14 is provided in a terminal of the moving part. Therefore, when the plunger 2 moved, air presenting within the hermetic chamber 14 flows out (or flows in) from the clearance composed of the periphery of the plunger 2 and the pipe 12. This exerts an air-dash-pot effect, so that a synergistic effect combined with an increase in a sliding resistance resulted from narrowing a clearance decreases a moving speed of the moving part, reducing loudness of an actuating sound.

As is evident from the above discussions, through the structure according to the first embodiment in which the valve 6 is made of elastic materials developing a tendency to yield when the valve abutted the sealing part 9 of the fluid passage

8, the present invention absorbs an impact had when the valve is sealed (at the time of collision), and reduces loudness of an actuating sound caused by a collision between the valve 6 and the sealing part 9.

Second Embodiment

Although no particular reference is made in the first embodiment, the valve 6 may be formed such that the valve covers a gap 15 formed between the rod 5 and the core 1 as shown in FIG. 5.

This prevents intrusion of foreign matters and liquid into a clearance composed of the periphery of the plunger 2 and the pipe 12.

In addition, the valve 6 may be arranged such that a part 6c of the valve 6 abuts the core 1 when the valve 6 is in an open state.

This facilitates regulation of a movable distance (stroke) when electricity is turned on or off, for reason that when electricity is not applied to the solenoid valve, a stroke of the moving part is limited by abutment of the valve 6 with the core 1.

Third Embodiment

Although no particular reference is made in the second embodiment, the valve 6 may be formed such that a part 6d of the valve 6 expands and contracts when the rod 5 moved, as shown in FIG. 6. That is, the valve 6 may be formed in bellows shape.

This continuously covers a gap 15 formed between the rod 5 and the core 1, even when the valve 6 closed (moved to the left as seen in FIG. 6) by applying electricity to the solenoid, and prevents intrusion of foreign matters and liquid from outside.

In addition, the valve 6 may be formed such that a part 6e of the valve 6 deforms as shown in FIG. 7 when the rod 5 moved, thereby exerting the same effect as the aforementioned case.